HLA Glossary

affected attributes	The specific attributes of an object class instance whose value in a federation execution may be affected by that instance's participation in a dynamic interaction with another object class.
Application Programmer's Interface (API)	A library of function calls which allows a federate to interact with the Runtime Infrastructure.
association	A type of static relationship between two or more object classes, apart from class-subclass or part-whole relationships.
attribute	A named portion of an object state.
attribute ownership	The property of a federate that gives it the responsibility to publish values for a particular object attribute.
cancellation	A mechanism used in optimistic synchronization mechanisms such as Time Warp to delete a previously scheduled event. Cancellation is a mechanism used within the Time Warp executive, and is normally not visible to the federate. It is implemented (in part) using the RTI's event retraction mechanism.
causal order	A partial ordering of messages based on the "causally happens before" ($\rightarrow$) relationship. A message delivery service is said to be causally ordered if for any two messages M_1 and M_2 (containing notifications of events E_1 and E_2, respectively) that are delivered to a single federate where $E_1 \rightarrow E_2$, then M_1 is delivered to the federate before M_2.
class	A description of a group of objects with similar properties, common behavior, common relationships, and common semantics.
class hierarchy	A specification of a class-subclass, or "is-a" relationship between object classes in a given domain.
CMMS	The Conceptual Model of the Mission Space (CMMS) is one of the three components of the DoD technical framework. CMMS are first abstractions of the real world and serve as a frame of reference for simulation development by capturing the basic information about important entities involved in any mission and their key actions and interactions. CMMS are simulation-neutral views of those entities, actions, and interactions occurring in the real world.
common federation functionality	Agreements on common simulation functionality (services and resources) which are finalized among all participants in the

	federation during the federation development process. Federation members identified during Federation Design will propose opportunities for common services in areas of assigned responsibilities (also established during Federation Design) during federation development for discussion and negotiation among all federation participants. For instance, agreements on common representations of terrain (data source, resolution, dynamic vs. static, etc.) and environment (required types, data sources, resolution, servers, etc.) would be negotiated and agreed to, as would any relevant federation-specific algorithms (e.g., extrapolation).
component class	An object class which is a component, or part of, a "composite" object which represents a unified assembly of many different object classes. The identification of a Component Class in the OMT should include cardinality information.
conceptual analysis	The step in the federation development and execution process which establishes the conceptual framework for the federation. It feeds the design of the overall federation structure. The conceptual view of the objects and interactions that must be represented in the federation is key to identifying reuse opportunities in established Federation Object Models (FOMs), and in determining candidates for federation membership. The high-level representation of the federation scenario refined during Conceptual Analysis also provides the basis for generation of a more detailed scenario instance during Federation Design/Development.
conservative synchronization	A mechanism that prevents a federate from processing messages out of time stamp order. This is in contrast to *optimistic* synchronization. The Chandy/Misra/Bryant null message protocol is an example of a conservative synchronization mechanism.
constrained simulation	A simulation where time advances are paced to have a specific relationship to wallclock time. These are commonly referred to as real-time or scaled-real-time simulations. Here, the terms *constrained simulation* and *(scaled) real-time simulation* are used synonymously. Human-in-the-loop (e.g., training exercises) and hardware-in-the-loop (e.g., test and evaluation simulations) are examples of constrained simulations.
coordinated time advancement	A time advancement mechanism where logical clock advances within each federate only occur after some coordination is performed among the federates participating in the execution, e.g., to ensure that the federate never receives an event notice in

	its past. ALSP, for example, uses coordinated time advancement.
current time (of a federate)	Same as federate time.
event	A change of object attribute value, an interaction between objects, an instantiation of a new object, or a deletion of an existing object that is associated with a particular point on the federation time axis. Each event contains a time stamp indicating when it is said to occur (also see definition of message).
event notice	A message containing event information.
exception	An exception in the programming language sense of a possible error - signaling return value. The initiator will be informed of these exceptions.
federate	A member of a HLA Federation. All applications participating in a Federation are called Federates. In reality, this may include Federate Managers, data collectors, live entity surrogates simulations, or passive viewers.
federate time	Scaled wallclock time or logical time of a federate, whichever is smaller. Federate time is synonymous with the "current time" of the federate. At any instant of an execution different federates will, in general, have different federate times.
federation	A named set of interacting federates, a common federation object model, and supporting RTI, that are used as a whole to achieve some specific objective.
federation execution	The federation execution represents the actual operation, over time, of a subset of the federates and the RTI initialization data taken from a particular federation. It is the step where the executable code is run to conduct the exercise and produce the data for the measures of effectiveness for the federation execution.
federation execution sponsor	Federation development begins with a user and a requirement. The federation execution sponsor is the organization which uses the results and/or products from a specific application of modeling and simulation. It is the group responsible for establishing the need for the development and execution of a federation. They also establish the framework for the Measures of Effectiveness (MOE) by which the results of the execution are employed.
Federation Object Model (FOM)	An identification of the essential classes of objects, object attributes, and object interactions that are supported by an HLA federation. In addition, optional classes of additional information

	may also be specified to achieve a more complete description of the federation structure and/or behavior.
federation objectives	This is the statement of the problem which is to be addressed by the establishment and execution of a federation. The description of the problem domain implicit in the objectives statement is critical for focusing the domain analysis activities in the conceptual analysis phase. It specifies the top level goals of the federation, and may specify the operational need or shortfall from which federation developers will derive a scenario for the federation execution. The federation objectives drive this specification, as the scenario development phase must utilize the statement of the objectives to generate a viable context for system evaluations intrinsic to the federation objectives. High-level testing requirements implied in the federation objectives may also drive the identification of well-defined "test points" during development of the federation scenario.
federation time axis	A totally ordered sequence of values where each value represents an instant of time in the physical system being modeled, and for any two points T_1 and T_2 on the federation time axis, if $T_1 < T_2$, then T_1 represents an instant of physical time that occurs before the instant represented by T_2. Logical time, scaled wallclock time, and federate time specify points on the federation time axis. The progression of a federate along the federation time axis during an execution may or may not have a direct relationship to the progression of wallclock time.
fidelity	The similarity, both physical and functional, between the simulation and that which it simulates.
FRED	The Federation Required Execution Details (FRED) is a global specification of several classes of information needed by the RTI to instantiate an execution of the federation. Additional execution-specific information needed to fully establish the "contract" between federation members (e.g., publish responsibilities, subscription requirements, etc.) is also documented in the FRED. The set of management requirements provides one source of input to the FRED specification, which will be recorded in a standardized format.
Greenwich Mean Time (GMT)	Mean solar time for the Greenwich meridian, counted from midnight through 24 hours. Also called “Universal Time [Coordinated]” (UTC) or “Zulu Time”.
happens before, causal ($\rightarrow$)	A relationship between two actions A_1 and A_2 (where an action can be an event, an RTI message send, or an RTI message receive) defined as follows: (i) if A_1 and A_2 occur in the same

	federate/RTI, and A_1 precedes A_2 in that federate/RTI, then $A_1 \rightarrow A_2$, (ii) if A_1 is a message send action and A_2 is a receive action for the same message, then $A_1 \rightarrow A_2$, and (iii) if $A_1 \rightarrow A_2$ and $A_2 \rightarrow A_3$, then $A_1 \rightarrow A_3$ (transitivity).
happens before, temporal ($\rightarrow_t$)	A relationship between two events E_1 and E_2 defined as follows: if E_1 has a smaller time stamp than E_2, then $E_1 \rightarrow_t E_2$. The RTI provides an internal tie-breaking mechanism to ensure (in effect) that no two events observed by a single federate contain the same time stamp.
independent time advancement	A means of advancing federate time where advances occur without explicit coordination among federates. DIS is an example of a federation using independent time advancement.
interaction	An explicit action taken by an object, that can optionally (within the bounds of the FOM) be directed toward other objects, including geographical areas, etc.
interaction parameters	The information associated with an interaction which objects potentially affected by the interaction must receive in order to calculate the effects of that interaction on it's current state.
known object	An object is known to a federate if the federate is reflecting or updating any attributes of that object.
LBTS	Lower Bound on the Time Stamp of the next time stamp ordered (TSO) message to be received by an RTI from another federate. Messages with time stamp less than LBTS are eligible for delivery by the RTI to the federate without compromising time stamp order delivery guarantees. TSO messages with time stamp greater than LBTS are not yet eligible for delivery. LBTS is maintained within the RTI using a conservative synchronization protocol.
local time	The mean solar time for the meridian of the observer.
logical time	A federate's current point on the logical time axis. If the federate's logical time is T, all time stamp ordered (TSO) messages with time stamp less than T have been delivered to the federate, and no TSO messages with time stamp greater than T have been delivered; some, though not necessarily all, TSO messages with time stamp equal to T may also have been delivered. Logical time does not, in general, bear a direct relationship to wallclock time, and advances in logical time are controlled entirely by the federates and the RTI. Specifically, the federate requests advances in logical time via the Time Advance Request and Next Event Request RTI services, and the RTI notifies the federate when it has advanced logical time explicitly

	through the Time Advance Grant service, or implicitly by the time stamp of TSO messages that are delivered to the federate. Logical time (along with scaled wallclock time) is used to determine the current time of the federate (see definition of federate time). Logical time is only relevant to federates using time stamp ordered message delivery and coordinated time advances, and may be ignored (by requesting a time advance to "infinity" at the beginning of the execution) by other federates.
logical time axis	A set of points (instants) on the federation time axis used to specify before and after relationships among events.
lookahead	A value used to determine the smallest time stamped message using the time stamp ordered service that a federate may generate in the future. If a federate's current time (i.e., federate time) is T, and its lookahead is L, any message generated by the federate must have a time stamp of at least T+L. In general, lookahead may be associated with an entire federate (as in the example just described), or at a finer level of detail, e.g., from one federate to another, or for a specific attribute. Any federate using the time stamp ordered message delivery service must specify a lookahead value.
mean solar time	A time measurement where time is measured by the diurnal motion of a fictitious body (called "mean Sun") which is supposed to move uniformly in the celestial Equator, completing the circuit in one tropical year. Often termed simply "mean time". The mean Sun may be considered as moving in the celestial Equator and having a right ascension equal to the mean celestial longitude of the true Sun. At any given instant, mean solar time is the hour angle of the mean Sun. In civil life, mean solar time is counted from the two branches of the meridian through 12 hours; the hours from the lower branch are marked a.m. (ante meridian), and those from the upper branch, p.m. (post meridian). In astronomical work, mean solar time is counted from the lower branch of the meridian through 24 hours. Naming the meridian of reference is essential to the complete identification of time. The Greenwich meridian is the reference for a worldwide standard of mean solar time called "Greenwich Mean Time" (GMT) or "Universal Time [Coordinated]" (UTC).
message	A data unit transmitted between federates containing at most one event. Here, a message typically contains information concerning an event, and is used to notify another federate that the event has occurred. When containing such event information, the message's time stamp is defined as the time stamp of the event to which it corresponds. Here, a "message" corresponds to a single event, however the physical transport media may

	include several such messages in a single "physical message" that is transmitted through the network.
message (event) delivery	Invocation of the corresponding service (Reflect Attribute Values, Receive Interaction, Instantiate Discovered Object, or Remove Object) by the RTI to notify a federate of the occurrence of an event.
model	A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. [DoD 5000.59]
object	A fundamental element of a conceptual representation for a federate that reflects the "real world" at levels of abstraction and resolution appropriate for federate interoperability. For any given value of time, the state of an object is defined as the enumeration of all its attribute values.
object model	A specification of the objects intrinsic to a given system, including a description of the object characteristics (attributes) and a description of the static and dynamic relationships that exist between objects.
object model framework	The rules and terminology used to describe HLA object models.
object ownership	Ownership of the ID attribute of an object, initially established by use of the Instantiate Object interface service. Encompasses the privilege of deleting the object using the Delete Object service. Can be transferred to another federate using the attribute ownership management services.
optimistic synchronization	A mechanism that uses a recovery mechanism to erase the effects of out-of-order event processing. This is in contrast to *conservative* synchronization. The Time Warp protocol is an example of an optimistic synchronization mechanism. Messages sent by an optimistic federate that could later be canceled are referred to as optimistic messages.
owned attribute	An object attribute that is explicitly modeled by the owning federate. A federate that owns an attribute has the unique responsibility to provide values for that attribute to the federation, through the RTI, as they are produced.
protocol catalog	The Protocol Catalog is envisioned as an on-line database that will contain standard definitions and formats of data exchanged between distributed simulations. This will help achieve a particular "collective" functionality distributed among multiple federates (e.g., air defense, logistics, ASW, etc.). During Federation Design, this repository is accessed (via automated browsing tools) to identify individual interactions for which a federate will be required, thus helping to define the federation

	design. The database will be accessible via the World Wide Web. Copies of the Protocol Catalog can be made and extended by government agencies as necessary to cover classified data. An official unclassified copy will be maintained by the DIS standards workshop.
real time	The actual time in which a physical process occurs.
real-time simulation	Same as constrained simulation.
reflected attribute	An object attribute that is represented but not explicitly modeled in a federate. The reflecting federate accepts new values of the reflected attribute as they are produced by some other federation member and provided to it by the RTI.
retraction	An action performed by a federate to unschedule a previously scheduled event. Event retraction is visible to the federate. Unlike "cancellation" that is only relevant to optimistic federates such as Time Warp, "retraction" is a facility provided to the federate. Retraction is widely used in classical event oriented discrete event simulations to model behaviors such as preemption and interrupts.
RTI Initialization Data (RID)	The data required by the RTI for operation. The required data come from two distinct sources, the Federation Object Model (FOM) product, and the Federation Required Execution Details (FRED).
Runtime Infrastructure (RTI)	The general purpose distributed operating system software which provides the common interface services during the runtime of an HLA federation.
scaled wallclock time	A quantity derived from a wallclock time defined as offset +[rate*(wallclock time - time of last exercise start or restart)]. All scaled wallclock time values represent points on the federation time axis. If the "rate" factor is k, scaled wallclock time advances at a rate that is k time faster than wallclock time.
scenario development	In this phase, the federation developer(s) formulate a scenario whose execution and subsequent evaluation will lead toward achieving the study objectives set forth by the federation sponsor. The scenario provides an identification of the major entities that must be represented by the federation, a conceptual description of the capabilities, behavior, and relationships (interactions) between these major entities over time, and a specification of relevant environmental conditions (e.g., terrain, atmospherics, etc.). Initial and termination conditions are also provided. The style and format of the scenario documentation (e.g., graphics, tables, text) are entirely at the discretion of the

	federation developer. However, communities of use may wish to establish scenario documentation standards among themselves to facilitate reuse of scenario components. The output of this phase is a functional-level scenario description, which is provided as input to the Conceptual Analysis phase. Certain key activities during Conceptual Analysis may also drive reiterations of the Scenario Development phase.
scheduling an event	Invocation of a primitive (Update Attribute Values, Send Interaction, Instantiate Object, or Delete Object) by a federate to notify the RTI of the occurrence of an event. Scheduling an event normally results in the RTI sending messages to other federates to notify them of the occurrence of the event.
simulation	A method for implementing a model over time. Also, a technique for testing, analysis, or training in which real-world systems are used, or where real-world and conceptual systems are reproduced by a model. [DoD 5000.59]
Simulation Object Model (SOM)	A specification of the intrinsic capabilities that an individual simulation offers to federations. The standard format in which SOMs are expressed provides a means for federation developers to quickly determine the suitability of simulation systems to assume specific roles within a federation.
time	The measurable aspect of duration. Time makes use of scales based upon the occurrence of periodic events. These are: the day, depending on the rotation of the Earth; the month, depending on the revolution of the Moon around the Earth; and the year, depending upon the revolution of the Earth around the Sun. Time is expressed as a length on a duration scale measured from an index on that scale. For example: 4p.m. local mean solar time means that 4 mean solar hours have elapsed since the mean Sun was on the meridian of the observer.
time flow mechanism	The approach used locally by an individual federate to perform time advancement. Commonly used time flow mechanisms include event driven (or event stepped), time driven, and independent time advance (real-time synchronization) mechanisms.
time management	A collection of mechanisms and services to control the advancement of time within each federate during an execution in a way that is consistent with federation requirements for message ordering and delivery.
time stamp (of an event)	A value representing a point on the federation time axis that is assigned to an event to indicate when that event is said to occur.

	Certain message ordering services are based on this time stamp value. In constrained simulations, the time stamp may be viewed as a deadline indicating the latest time at which the message notifying the federate of the event may be processed.
time stamp order (TSO)	A total ordering of messages based on the "temporally happens before" ($\rightarrow_t$) relationship. A message delivery service is said to be time stamp ordered if for any two messages M_1 and M_2 (containing notifications of events E_1 and E_2, respectively) that are delivered to a single federate where $E_1 \rightarrow_t E_2$, then M_1 is delivered to the federate before M_2. The RTI ensures that any two TSO messages will be delivered to all federates receiving both messages in the same relative order. To ensure this, the RTI uses a consistent tie-breaking mechanism to ensure that all federates perceive the same ordering of events containing the same time stamp. Further, the tie-breaking mechanism is deterministic, meaning repeated executions of the federation will yield the same relative ordering of these events if the same initial conditions and inputs are used, and all messages are transmitted using time stamp ordering.
transportation service	An RTI provided service for transmitting messages between federates. Different categories of service are defined with different characteristics regarding reliability of delivery and message ordering.
true global time	A federation-standard representation of time synchronized to GMT or UTC (as defined in this glossary) with or without some offset (positive or negative) applied.
unconstrained simulation	A simulation where there is no explicit relationship between wallclock time and the rate of time advancements. These are sometimes called "as-fast-as-possible" simulations, and these two terms are used synonymously here. Analytic simulation models and many constructive "war game" simulations are often unconstrained simulations.
Universal Time [Coordinated] (UTC)	The same as Greenwich Mean Time. A nonuniform time based on the rotation of the Earth, which is not constant. Usually spoken as, "Coordinated Universal Time".
wallclock time	A federate's measurement of true global time, where the measurand is typically output from a hardware clock. The error in this measurement can be expressed as an algebraic residual between wallclock time and true global time or as an amount of estimation uncertainty associated with the wallclock time measurement software and the hardware clock errors.